TESTIMONY

Statement of
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Price Volatility in Climate Change Legislation

before the
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Chairman Rangel, Congressman Camp, and Members of the Committee, thank you for the invitation to testify this morning on the issue of addressing price volatility in climate change legislation.

Growing concentrations of greenhouse gases raise the specter of large-scale climate change and global warming over the next hundred years. Atmospheric concentrations of carbon dioxide have risen from a pre-industrial level of 280 parts per million to the current level of over 380. Because greenhouse gases persist in the atmosphere for many hundreds of years, the impact of emissions today will have a significant impact on atmospheric concentrations for centuries to come. The magnitude and distribution of damages from climate change is uncertain but the risks are high from inaction.[1]

The United States has the opportunity to take a leading role in the international arena on climate change. While it is highly unlikely that we can achieve significant reductions in global concentrations of greenhouse gases without an international agreement that includes China and other large developing countries, it is equally true that we are unlikely to obtain their agreement to undertake significant actions until the United States takes action. By taking global leadership the United States can help to break the impasse that stands in the way of a truly international agreement that can realistically address this problem.

The subject of today's hearing is price volatility in climate change legislation. Price volatility is of considerable concern to the business community and to the public. While people dislike high gasoline prices, for example, they *especially* dislike unexpectedly high gas prices to which they cannot adjust. It will be important for Congress to design a program to limit emissions in a way that minimizes unexpected price shocks to which firms cannot easily adjust and anticipate.

Economists are generally in agreement that using market-based mechanisms is a superior approach on efficiency grounds to reduce greenhouse gas emissions. The two main approaches are a carbon tax and a cap-and-trade system of marketable permits for emissions. These market-based approaches are superior to regulatory approaches in a number of dimensions. They ensure that all polluters, regardless of industrial sector, face the same marginal cost of abatement – a necessary condition for efficiency. They provide the right incentive for greater pollution reductions to shift from firms or sectors with high marginal abatement costs to those with low marginal abatement costs. Pricing pollution also encourages innovation, given the potential for reducing pollution at lower cost with new technology and thus reducing the price that needs to be paid for emissions of greenhouse gases.

The two approaches differ in the degree of certainty they provide on one of two dimensions. A pure cap-and-trade system provides certainty over the path of emissions from the regulated sector during the control period.[2] It does not, however, provide any

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[1] I discuss the risks of climate change in greater detail in an appendix to this testimony.

[2] Note that emissions from any sector not included in the system are not controlled. Nor is it possible to ensure that substitution between emissions from the controlled to the uncontrolled sector does not occur.

certainty over the price of the permits for regulated firms. In contrast, a carbon tax provides certainty over the price regulated firms will face – the tax rate – but does not provide certainty over emissions. These observations must be qualified in two ways. First, hybrid cap-and-trade approaches can be designed to reduce price volatility. Other witnesses today will be speaking about these approaches. Hybrid tax approaches also exist and I will discuss one such approach below. Second, a pure tax or cap-and-trade-system can be adjusted by future lawmakers. Thus the certainty over emissions or price is conditional on whatever policy is enacted and does not account for future policy changes.

My testimony makes the following key points about these issues:

- Price volatility may reflect short-run fluctuations in weather, equipment outages, unexpected demand or other temporary phenomena. This differs from long-run uncertainty due to fundamental uncertainties over technological innovation, adaptation opportunities or other such long-run phenomena. Climate change policy should allow prices to respond to long-run impacts and insulate firms and consumers from short-run price volatility.
- A pure carbon tax with a legislatively established set of tax rates over the control period provides the greatest certainty over the future carbon price.
- The trade-off between price volatility and certainty over emissions is unavoidable. But smart policy can mitigate this trade-off. This can be done under either a cap-and-trade or tax approach.
- Cost containment mechanisms in cap-and-trade systems can be complex and lead to unintended and undesirable outcomes.
- A carbon tax has other desirable properties that should be taken into account. It can be implemented in reasonable short order and can piggyback on existing tax structures.

Price Volatility Under Existing Cap-and-Trade Programs

Price uncertainty is a significant concern with cap-and-trade programs. At the outset, it is important to distinguish between short-run and long-run price uncertainty. Short-run price uncertainty (or volatility) can reflect short-term weather conditions, equipment outages and other temporary phenomena. It is not desirable for firms to face fluctuating prices on a daily (or perhaps hourly) basis due to these sorts of phenomena.

Long-run price uncertainty reflects our inability to predict whether and when various technologies to reduce greenhouse gas emissions come on line. Considerable uncertainty exists, for example, over the feasibility of carbon capture and storage at scale. Similarly political and technological constraints on nuclear power could significantly affect long-run permit prices.

Carbon taxes ensure a given price for carbon emissions while permit prices in a cap-and-trade system are uncertain. Price volatility for cap-and-trade systems is well known. The EU ETS illustrated this dramatically in April 2006 when CO_2 permit prices fell sharply on the release of information indicating that the ETS Phase I permit allocations were overly generous. The December 2009 futures price fell from a peak of €32.90 on April 20 to €18.90 on May 3. Prices rebounded briefly but drifted downward for much of the rest of the year (Figure 1). They then gradually rose during 2007 and reached a peak of €30.53 on July 1, 2008. Since then the price collapsed to a low of €8.20 on Feb. 12, 2009. Currently they are hovering in the range of €12 per ton.

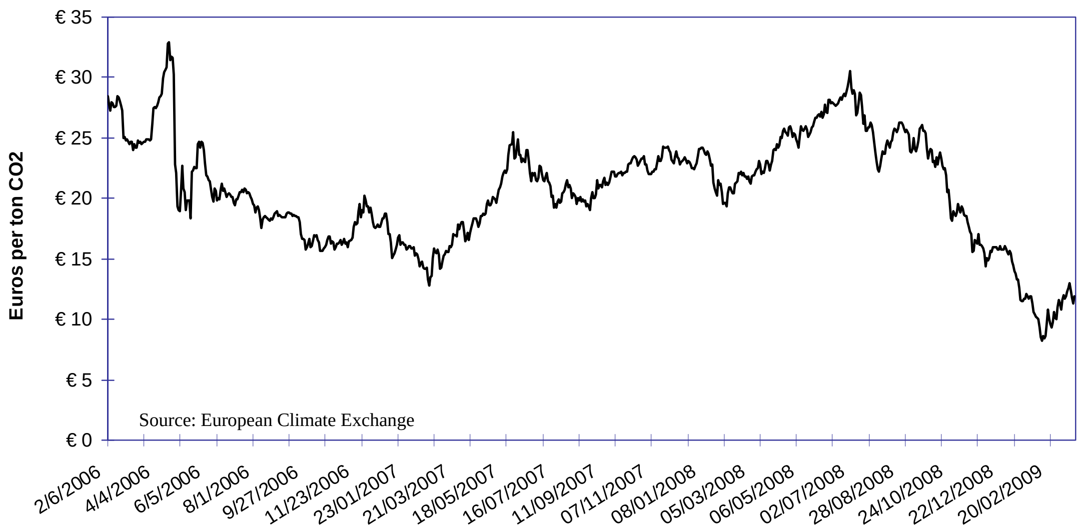

Figure 1. ECX Futures Contract Settlement Price

The permit price volatility experienced in the Europe's cap-and-trade program is not unique. NO_x prices in the Northeast states' Ozone Transport Commission jumped to nearly $8,000 per ton in early 1999 before falling back to more typical levels between $1,000 and $2,000 per ton. Permit prices for the California Regional Clean Air Incentives Market (RECLAIM) rose abruptly from under $5,000 per ton of NO_x to nearly $45,000 per ton in the summer of 2000. Permit prices in EPA's Acid Rain Program rose to nearly $1,600 per ton SO_2 in late 2005 from a price of roughly $900 at the beginning of the year.

Unexpectedly high permit prices erode political support for the program and led in the RECLAIM market to a relaxation of the permit cap in response to the high prices. The response in the RECLAIM market in particular should provide a cautionary note for policy makers. Highly volatile permit prices are likely to create dissatisfaction with a cap-and-trade program and make business long run investment planning difficult.

Cost Containment Mechanisms in Cap-and-Trade Systems

Provisions to limit short run volatility will be essential to build political and popular support for any climate change legislation. The first point to make here is that cost containment provisions are entirely unnecessary under a carbon tax. Second, while various approaches exist for reducing short run volatility in a cap-and-trade system, all such approaches come with some degree of complexity and uncertainty over their ultimate ability to dampen price volatility.

One approach to limiting volatility is to include a "safety-valve" provision – perhaps with a price floor combined with a ceiling.[3] This allows firms to purchase an unlimited number of permits at a set price and thus sets a ceiling on the price of permits. If the market price for permits is below the safety valve price, then firms will simply purchase permits in the open market. Once permit prices reach the value of the safety valve, firms will purchase any needed permits directly from the government. A floor price on emissions – as contained in the symmetrical safety valve proposal – is equivalent to a cap-and-trade system combined with a carbon tax set at the floor price.

If one is going to take the cap-and-trade approach the safety valve approach has much to commend. It is transparent and it puts clear limits on the upside and downside price movement. If the safety valve is binding then, in effect, the cap-and-trade system has been converted into a carbon tax. But it does so while maintaining the complexity of the cap-and-trade system.

One problem with the traditional safety valve approach is that anticipation of future government policy to reduce emissions creates an arbitrage opportunity. If a cap-and-trade program with unlimited banking is designed, then incentives will exist to bank low price permits in anticipation of future tightening of the cap. While one can require that any permits purchased through a safety valve be used in the year they are purchased, they can still free up other permits to be banked for the future thereby achieving the result of substituting low price permits for future higher price permits.

One way to address this concern is to limit the number of permits that may be purchased at the safety valve price. This is the approach that a strategic allowance reserve policy takes.[4]

Putting constraints on the number of safety valve permits that may be purchased may address the arbitrage opportunity raised by the anticipation of future policy tightening. But it also raises its own issues. Many of the cap-and-trade policies currently under consideration call for extremely sharp reductions in emissions (more precisely allowance allocations) by the middle of the century. Various analyses of these policies suggest that allowance banking will be sizable in the early phase of the program.[5] Making more

[3] See, for example, Dallas Burtraw's testimony to the Committee on Ways and Means on Sept. 18, 2008.

[4] See Brian C. Murray, Richard G. Newell and William A. Pizer. 2009. "Balancing Cost and Emissions Certainty: An Allowance Reserve for Cap-and-Trade." *Review of Environmental Economics and Policy,* 3(1), pp. 84-103.

[5] See, for example, Sergey Paltsev, John M. Reilly, Henry D. Jacoby, Angelo C. Gurgel, Gilbert E. Metcalf, Andrei P. Sokolov and Jennifer F. Holak. 2007. "Assessment of U.S. Cap-and-Trade Proposals: Appendix D – Analysis of the Cap and Trade Features of the Leiberman-Warner Climate Security Act (S. 2191)." Cambridge, MA: MIT Joint Program on the Science and Policy of Global Change.

permits available in the present through an allowance reserve that borrows against future allocations may simply lead to further banking to offset anticipated higher future prices due to a tightening of the future cap. In other words the reserve may be ineffective at damping price volatility.

Designing a Carbon Tax to Address Concerns About Emissions

A price based approach has two critical design elements (among others). First, it must specify the price for carbon emissions in the initial year of the program. Second, it must specify a price path over time. The initial tax rate should be low enough to avoid adverse economic impacts. But it should be high enough to send the signal to firms and consumers that a serious climate change policy has been enacted. Increasing the tax over time in a predictable manner to a sufficiently high level to trigger the technological innovations we will need to move to a carbon free economy is also essential. The principle of a low initial tax that gradually increases over time is embedded in Cong. Stark's Save Our Climate Act of 2009 (H.R. 594), Cong. Larson's America's Energy Security Trust Fund Act of 2009 (H.R. 1337), and Cong. McDermott's Clean Environment and Stable Energy Market Act of 2009 (H.R. 1683).

As others have suggested the two positions of pure cap-and-trade and carbon tax are extremes on a continuum of policies of market-based instruments to reduce emissions. Other witnesses today have or will testify to the possibility of hybrid cap-and-trade systems that reduce price volatility. I would like to suggest an alternative approach whereby a carbon tax is designed to meet emissions targets during a control period while minimizing price uncertainty. I call this the Responsive Emissions Autonomous Carbon Tax (REACT).[6] It works as follows.

- An initial tax and standard growth rate for the tax is set for the first year of a control period.
- Benchmark targets for cumulative emissions are set for the control period. The law could require that the targets be met at annual, five-year, ten-year or some other time interval.
- If cumulative emissions exceed the target in the given years, the growth rate of the tax would increase from its standard growth rate to a higher catch-up rate until cumulative emissions fall below the target again.

This policy approach ensures that long-run targets are met while price stability is achieved in the short run. Given the ability to predict emissions in the short run and the transparent nature of the tax, firms would be able to predict with considerable certainty what the growth rate of the tax will be in the near term thereby providing greater clarity for their planning purposes.

[6] See Gilbert E. Metcalf, "Designing a Carbon Tax to Provide Certainty Over Long-Run Emissions Reductions," Tufts University, Unpublished manuscript.

The approach I am taking in REACT is similar in spirit to the approach proposed in H.R. 1337. The main difference is that I use a percentage adjustment to the tax rate rather than a fixed dollar amount. It is also similar to H.R. 1683 with the main difference being that the tax adjustment is built into the law rather than delegated to the Secretary of the Treasury.

As an example of how REACT could be designed, assume benchmark targets based on the permit allocations in the Warner-Lieberman Climate Security Act of 2007 (S. 2191). Also assume that the tax goes into effect in 2012 with a control period running through 2050. The standard growth rate for the tax is 4 percent (plus inflation) and a higher catch-up rate of 10 percent (plus inflation). The catch-up rate is triggered when cumulative emissions in any year exceed cumulative target emissions.

Initial modeling that I have done with these assumptions suggests that such an approach can minimize price volatility while ensuring that long-run emission reductions are achieved. This typically occurs with near-term increases in the tax at the lower rate of growth with mid-term – fifteen to twenty years out – increases in the growth rate to the high rate followed by returns to the lower growth rate near the end of the control period. My modeling has not taken into account an important behavioral effect that may occur. Firms may anticipate cumulative emissions rising to the point where they may trigger a shift to the high growth rate in the tax and undertake additional abatement activities to avoid this outcome. Further modeling is needed to understand whether this is a potentially significant response or not.

The REACT approach addresses the objection that a carbon tax does not ensure a hard cap on greenhouse gas emissions over the control period. An overall cap can be maintained while insulating consumers and businesses from short-run fluctuations in carbon prices that add volatility to energy prices and undermine support for climate change legislation. It does this with a transparent mechanism for adjusting the price of emissions over the control period.

Other Advantages of a Price Based Approach

While the focus of this hearing is on price volatility, it is useful to consider additional advantages of a price-based approach to pricing emissions. Let me focus on three: transparency, ease of implementation, and the principle of double neutrality.

As we have learned in the recent financial crisis involving sub-prime mortgages, collateralized debt obligations, credit default swaps, and other new structured investment instruments, transparency is essential to the smooth functioning of financial markets. Going down the path of a cap-and-trade system with some form of cost containment, we are creating new financial instruments with an annual value ten or more times greater than the value of any other environmental permit-based system enacted to date in the United States. We face great uncertainty over how financial players will respond to this new market and how it will develop over time. A price based approach, on the other hand, faces none of this uncertainty.

Implementation is also more straightforward with a price based approach. We have a time-tested administrative structure for collecting taxes that can ramp up an upstream carbon tax in relatively short order. Firms that would be subject to a carbon tax are already registered with the IRS and have whole departments within their firms that carry out the record keeping and reporting for tax payments. Coal producers already pay an excise tax to fund the Black Lung Trust Fund and oil producers pay a tax to fund the Oil Spill Trust Fund. We also have precedents for refundable credits for sequestration activities in federal fuels tax credits. In contrast, we have no administrative structure for running an upstream carbon cap-and-trade program. A recent CBO report details the lead-time required to establish allocations.[7] All this suggests that we can implement carbon pricing through a tax more quickly than through a cap-and-trade system.

Finally, a key principle of any carbon control scheme should be the double neutrality principle: revenue neutrality and distributional neutrality. While this principle can be upheld under either a cap-and-trade system or a carbon tax, I would argue that it is more straightforward under the latter approach. Revenue neutrality means using the revenue to lower other existing taxes to avoid the charge that we are raising the fiscal burden on American taxpayers. Distributional neutrality means that we direct the refunded taxes in a way that ensures that lower-income households do not bear a disproportionate burden of carbon pricing. Double neutrality can be achieved while providing the appropriate incentive to reduce carbon emissions through a higher price for carbon intensive activities.

Thank you for this opportunity to testify today.

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[7] Congressional Budget Office. 2008. Policy Options for Reducing CO_2 Emissions. Washington, DC: Congressional Budget Office.

Appendix: The Risks of Climate Change

The most recent set of reports by Intergovernmental Panel on Climate Change Fourth Assessment Report's Working Groups provide additional evidence to support the role and consequences of anthropogenic warming.[8] Working Group I describes the build-up of greenhouse gas concentrations and the role of human activity clearly:

> Global atmospheric concentrations of carbon dioxide, methane and nitrous oxide have increased markedly as a result of human activities since 1750 and now far exceed pre-industrial values determined from ice cores spanning many thousands of years. The global increases in carbon dioxide concentration are due primarily to fossil fuel use and land use change, while those of methane and nitrous oxide are primarily due to agriculture.
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> IPCC (2007) p. 2

Figure A1 from Working Group I's report provides a record of changes in temperature, sea level, and snow cover. The data points measure changes from the 1961 – 1990 averages. The solid lines graph smoothed decade averages and the blue shading indicates uncertainty intervals (see report discussion on page 6).

The figure illustrates that global average temperatures have increased over the twentieth century with accelerated warming in the past thirty years. Sea levels on average are also rising with an average increase over the twentieth century of roughly 150 mm. Sea level rise is due to thermal expansion of the oceans along with run off from glaciers and ice caps. According to Working Group I's report, thermal expansion can account for roughly 40 percent of the explainable sea level rise between 1961 and 2003 (Table SPM.1.). For the period 1993 to 2003, ice melt from glaciers and ice caps as well as the Greenland and Antarctic Ice Sheets are predominantly responsible for observed sea level rise. While Northern Hemisphere snow cover appears to be trending downward, the uncertainty is sufficiently large that one cannot rule out the absence of change in snow cover, based on the data reported in Figure A1.

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[8] Intergovernmental Panel on Climate Change. "Contribution of Working Group I to the Fourth Assessment Report, Summary for Policymakers." IPCC, 2007.

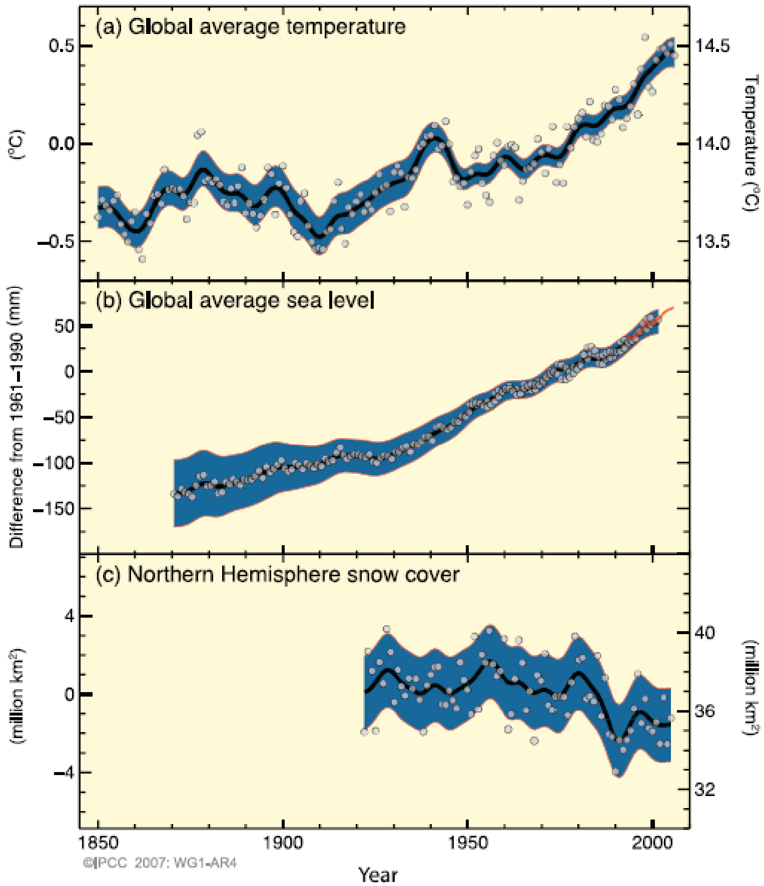

Figure A1: Climate Change Record

Projections of future warming are less precise. The IPCC developed a number of emission scenarios in their Special Report on Emission Scenarios (SRES) and asked modelers to run scenarios using those assumptions.[9] Figure A2 from IPCC Working Group I's report provides projections of temperature increases arising from those scenarios.

The solid lines are averages across different models of temperature changes for different scenarios relative to the 1980-1999 average temperature. The grey bars at right provide the likely range of temperature changes for each scenario with the horizontal line a measure of the mean estimate in 2100.[10] Scenario A1F1 is a scenario with rapid economic growth in a fossil fuel-intensive world. In contrast the B1 scenario models a world shifting away from energy intensive activities towards a more service-oriented economy. While great uncertainty is represented across (and within) the various

[9] See page 18 of Intergovernmental Panel on Climate Change. "Contribution of Working Group I to the Fourth Assessment Report, Summary for Policymakers." IPCC, 2007 for a description of the scenarios and the SRES.

[10] "Likely" is defined in the IPCC report as the probability that the actual temperature increase will lie in this grey area is greater than 66 percent.

scenarios illustrated here, none suggest that temperature will stabilize in the absence of a climate policy.

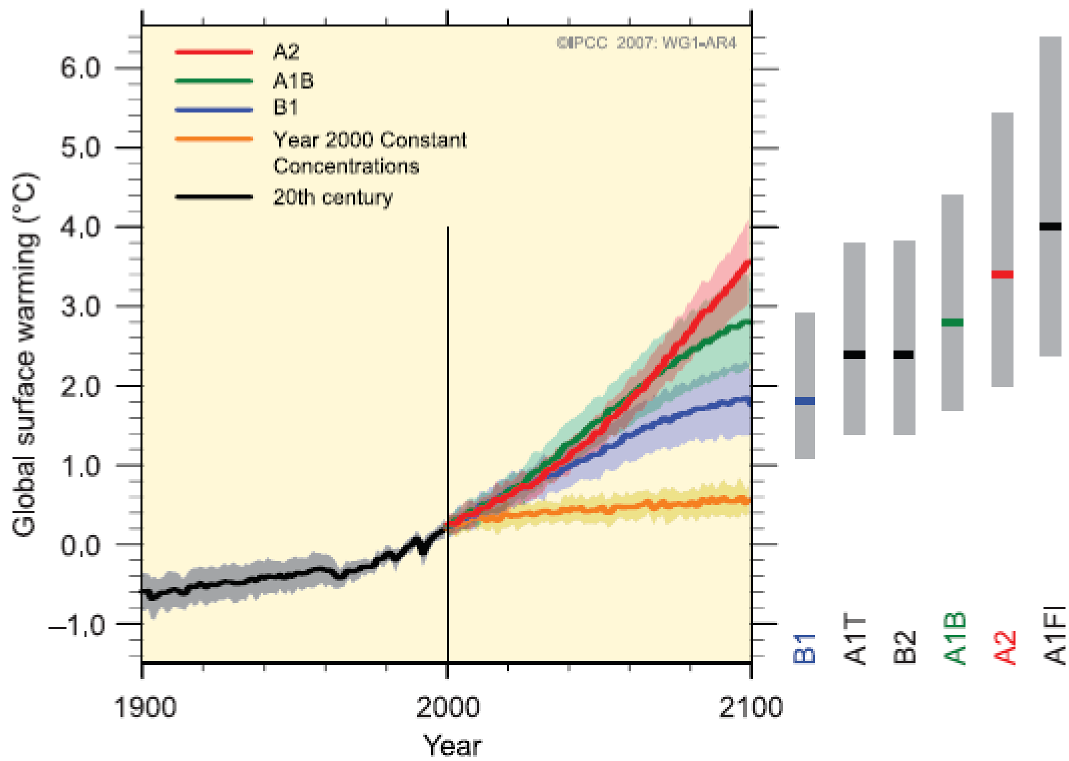

Figure A2: Possible Temperature Increases

The IPCC's Working Group II focused on the impacts of climate change.[11] They concluded that "many natural systems are being affected by regional climate changes, particularly temperature increases," p. 1. The report goes on to enumerate a number of potential impacts. Africa is especially at risk. By 2020, the IPCC report notes that "between 75 and 250 million people are projected to be exposed to an increase of water stress due to climate change. If coupled with increased demand, this will adversely affect livelihoods and exacerbate water-related problems" page 8. The report goes on to note that

> Agricultural production, including access to food, in many African countries and regions is projected to be severely compromised by climate variability and change. The area suitable for agriculture, the length of growing seasons and yield potential, particularly along the margins of semi-arid and arid areas, are expected to decrease. This would further adversely affect food security and exacerbate malnutrition in the continent. In some countries, yields from rain-fed agriculture could be reduced by up to 50% by 2020.
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> IPCC Working Group II, page 8.

[11] Intergovernmental Panel on Climate Change. "Contribution of Working Group II to the Fourth Assessment Report, Summary for Policymakers." IPCC, 2007

North America will also be impacted. The report notes issues of reduced snow pack in Western mountains and decreased summertime water flows, for example. This would place additional strains on already taxed water systems in the West. Forest fire risk rises and heat-sensitive crops (such as corn and soybeans) may be adversely affected. On the other hand, some crops (such as oranges and grapes) may experience an increase in yield with warmer temperatures, illustrating the point that climate change is a complex process with winners as well as losers. All the impacts described above suggest the importance of significant action now.

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Metcalf has served as a consultant to numerous organizations including, among others, the U.S. Department of the Treasury, the U.S. Department of Energy, and Argonne National Laboratory. He currently serves as a member of the National Academy of Sciences Committee on Health, Environmental, and Other External Costs and Benefits of Energy Production and Consumption. In addition he serves or has served on the editorial boards of *The Journal of Economic Perspectives*, *The American Economic Review*, and the *Berkeley Electronic Journals in Economic Analysis and Policy*.

Metcalf's primary research area is applied public finance with particular interests in taxation, energy, and environmental economics. His current research focuses on policy evaluation and design in the area of energy and climate change. He has published papers in numerous academic journals, has edited two books, and has contributed chapters to several books on tax policy. Metcalf received a B.A. in Mathematics from Amherst College, an M.S. in Agricultural and Resource Economics from the University of Massachusetts Amherst, and a Ph.D. in Economics from Harvard University.